



Flood Hazard Management Issues in Snohomish County



September 2010

Current Flood Management Conditions

► Brief History

Before any historical records were kept, Native Americans lived on Snohomish County's riverbanks, fished from the waters, used the waterways for transportation and were affected by seasonal floods.

European settlement began in the mid-1800s and logging and farming activities began. By 1910, farmers and other residents formed the first diking districts in the County. Government involvement in flooding and flood control also began early, primarily through the U.S. Army Corps of Engineers (Corps) in the early 1900s. Early efforts included the construction of weirs, dikes and levees and the practice of snagging boats to remove instream logs. The County was actively involved by the 1930s, obtaining numerous flood control easements which it still holds.



Summary

Flooding is a natural part of river and stream systems. It has environmental benefits but can damage floodplain property and create public safety hazards. Two main factors contribute to flood hazards: the size and frequency of peak flows that overtop river and stream banks, and the amount of floodplain development that is exposed to damage when the river banks overtop.

The larger Snohomish and Stillaguamish watersheds have forested headwaters and flood flows are generated primarily by precipitation (including snow) in the mountains. Bank erosion, channel migration, inundation and levee breaches are the principal causes of flood damage along these major rivers.

In the smaller, more urban South County watersheds, flood flows are generated primarily by rainfall. Dense development has increased stormwater runoff, resulting in larger, more frequent flood flows. Because businesses, roads and houses have been built in the floodplain, there is a risk of large flood damages. These issues are primarily addressed in the 2002 Drainage Needs Report.

Through the 1970s, the general response to flood damage was to rebuild larger, more durable flood control structures. Few regulations governed the location of new development in the floodplain at this time. As a result, numerous houses were built; many in more dangerous locations than the first generation of farmhouses.

On March 15, 1984, the County became a member of the National Flood Insurance Program (NFIP) and adopted flood hazard regulations and mapping. These regulations contain strong no-build and low-density zones.

The National Flood Insurance Program (NFIP) is a federal program administered by the Federal Emergency Management Agency (FEMA) that was established to allow property owners in participating communities to purchase insurance protection against losses from flooding. Participation in the NFIP is based on an agreement between local communities and the federal government that states if a community adopts and enforces a floodplain management ordinance to reduce future flood risks to new construction and substantial improvements in Special

SWM's goal is to reduce the potential for physical injury and property damage associated with flooding. To achieve this goal, SWM works to prevent the creation of new flood hazards and to reduce existing hazards.

Projects proposed to meet this goal are evaluated to ensure that they are cost-effective, do not increase upstream or downstream flooding, and benefit (or do not impair) environmental functions.

SWM's flood hazard management programs include flood hazard management plans (including river monitoring and flood warning), capital improvement projects (including maintenance and emergency response, and public outreach.

The number of Snohomish County residents affected by flooding has increased, while funding for flood hazard management has remained static for many years. The County has a limited ability to fund flood hazard reduction measures. Delaying repairs or enhancements until funds are available can increase long-term costs, since previously flooded structures risk new flood damage each winter. Long-term mitigation measures, such as home elevations and acquisitions, can lift the burden of future flood damage.



Flood Hazard Areas, the Federal Government will make flood insurance available within the community at a low cost.

Some of the larger floods in Snohomish County occurred in 1897, 1917, 1932, 1951, 1958, 1959, 1975, 1977, 1980 and 1986. More recently, large floods occurred in 1990 (twice), 1995 (twice), 1996, 1997, 2003, 2006, 2007 and 2009.



Sultan 1990



Island Crossing, 2009

Some damage totals from recent floods are shown below:

| Flood Event | FEMA Disaster Record # | Date | FEMA Prelim. Damage Assessment |
|-------------|------------------------|---------|--------------------------------|
| 2003 flood | 1499-DR | 11/2003 | \$18,000,000 |
| 2006 floods | 1641-DR | 2/2006 | \$1,975,369 |
| | 1671-DR | 11/2006 | \$18,772,675 |
| 2009 flood | 1817-DR | 1/2009 | \$3,284,412 |

Historical data on flood levels at various locations on the big rivers is available online through the Snohomish County Flood Warning System, which is covered in more detail on page X of this handout.

► Causes of Flood Hazards

Flood Flows in Lowland Streams and Big Rivers

Weather patterns and land uses are the primary factors affecting flooding in Snohomish County. The smaller urban streams of the western Snohomish County lowlands flood almost exclusively due to rainfall only. Development and associated impervious surfaces have increased stormwater runoff, resulting in dramatic increases in the frequency and severity of flooding. Peak flows in these urban streams often double or triple compared to pre-development rates.

In contrast, the big rivers in Snohomish County flood due to precipitation in the mountains. The county's largest floods occur on these rivers and are often caused by a combination of intense rainfall and melting snowpack. Because flows generated in the forested mountains dwarf what is produced by the more developed lowland areas, development is not a major contributor to the flood flows on these rivers. Forestry is the dominant land use in the mountainous headwaters, and its effects on flooding can be an important factor in large river watersheds.

Types and Causes of Flood Damages

Flood damages are generally due to one of three causes:

- **Inundation**- Inundation Is the entry of floodwater into structures that are not built above flood levels. In a home, extensive replacement of drywall, insulation, flooring and other systems along with loss of personal belongings is typical. This type of damage is mostly limited to homes and businesses. Most public infrastructure such as roads and utilities are unaffected by temporary inundation.
- **Erosion** – Erosion of the land on which a structure sits will cause complete failure and loss. The erosion may be at a localized bank or part of a larger scale river shift. Erosion around bridges (scour) is a leading cause of bridge failures nationwide. Erosion can easily undermine land that is above flood levels. Erosion damages affect all property and infrastructure on the floodplain.
- **Flood Control Structure Failure** – Although flood control structures such as dikes and levees protect properties during small floods these facilities can increase flood damages if they fail. In an undiked river, floodwaters quickly rise over the riverbanks and lose some of their destructive force as they spread over the floodplain. If sections of a river are diked, floodwaters are constricted so that the so that the river is higher, faster and gains more destructive force. Dike breaches, which are common during large floods, can cause far more damage to lands and structures behind them than would occur under natural flooding conditions.



Oso Levee



Watershed-Specific Issues

► Snohomish Watershed Snohomish River Channelized

The upper Skykomish River (including the North and South Forks) is a swift, powerful river that causes most of its flood damage through bank erosion and channel migration. Many summer cabins and permanent residences are built in locations that could be eroded in a single flood. In 1990, for example, the Thanksgiving Day flood washed over 20 structures away, and damages to the Index-Galena road exceeded \$2.8 million. County roads, railways, and other infrastructure will continue to be at risk due to the dynamic nature of the river.



The lower Skykomish River is more stable, due to the gentler slopes, more extensive bank armoring and dikes along its length. However, bank erosion still occurs, along with flooding of houses built at low elevations. The series of dikes built to help contain the river has also suffered significant damage during floods. SWM has maintenance obligations on some of the dikes on the Skykomish, most of which required repeated repairs over time.

The Snohomish River is bordered almost entirely by levees built relatively low and designed to overtop during flood events that exceed a 5-year return interval. Over 45 miles of levee protect about 20,000 acres of primarily agricultural lands. Most of these levees are maintained by diking and flood control districts. The County fully or partly assists in maintenance where county roads run along levees. Damages along the Snohomish are primarily from inundation and levee breaches. Costs to repair these breaches can easily run into the millions of dollars, and federal funding for such repairs has become much harder to secure. In the lower delta, deep weak soils have led to levee subsidence. Failures may occur even during non-flood times.

► Stillaguamish Watershed

Flood damages on the North Fork of the Stillaguamish River are similar to those on the Skykomish River, with bank erosion threatening buildings and roads a common occurrence. Peak flows on this river are increasing in a manner not seen on other rivers in the region, possibly due to the more intense forest harvest rates here than in other watersheds. In addition, sediment loads from landslides induced by past forest practices have aggravated flood damages by filling in the river channel and increasing river migration. The Whitehorse Trail, a County Parks facility utilizing an abandoned railroad grade, suffered

extensive damages in the floods of the 1990s. The County has obligations on one flood control structure and has been involved in several others.

Flood damages on the upper South Fork Stillaguamish are limited compared to other areas. Much of the floodplain is either uninhabited federal land, or the river occupies an incised canyon that has prevented development. Nevertheless, there are areas where bank erosion threatens residences and infrastructure. The Mountain Loop Highway is a federal forest highway, maintained cooperatively by the US Forest Service and Snohomish County. This highway runs up the valley and has chronic maintenance challenges from both the river itself and from side tributaries.

The Main Stem Stillaguamish River has extensive bank armoring and levees that confine the channel and limit meandering. Several decades of commercial dredging on gravel bars throughout the river removed more gravel than was naturally replaced by downstream gravel migration. This resulted in channel down-cutting and likely helped keep the channels in their present, somewhat stable course.



The Corps assumes full maintenance for 26 separate flood control structures totaling around 8 miles in this river. The County has responsibility for approximately 4 miles of roads located along riverbanks, and the Stillaguamish Flood Control District maintains around 25 miles of levees in the lower main stem. Damages are incurred primarily from inundation. Flood flows at the lower end of the river are funneled toward Stanwood, where the levee system traps the water and prevents it from reaching Port Susan and Puget Sound. This situation results in much higher flood levels than would occur naturally.

► South County Watersheds

The two largest systems in south Snohomish County are Swamp Creek and North Creek. Although these creeks are dwarfed by the Snohomish and Stillaguamish Rivers, they share some of the same flooding issues.



Both creeks have floodplain areas where significant development has occurred. For example, lower North Creek in Bothell has hundreds of millions of dollars of real estate on the floodplain protected by a levee system. Flows in these creeks have been fundamentally altered by watershed development. These changes in flow and development in the floodplain have

increased the risk of large flood damages. Flood flows on North Creek have doubled compared to historic times. Older bridges and other infrastructure on these creeks are prone to damage from these increased flows.

County Response

► Surface Water Management Program Priorities

In response to serious flood hazards in river valleys throughout the county, the Surface Water Management Division (SWM) developed a comprehensive strategy of goals, principles and program priorities to guide the allocation of limited public resources in flood hazard management.

Goals

Surface Water Management's flood hazard management priorities are guided by its mission and goals, especially Goal 4: Reduce the potential for physical injury and property damage associated with flooding. This goal meshes well with the goals of Washington State for flood hazards:

- Reduce hazards to human life.
- Reduce damage to public and private property.
- Reduce the environmental impacts of flood control projects.
- Reduce the long-term costs of flood hazard management.

Guiding Principles

Together with the goals, SWM's flood hazard management program uses the following principles to guide choices about alternative expenditures and actions. These principles favor avoiding exposure to risk over costly rescue and repair efforts.

- Keep structures and people out of the path of floodwaters to the greatest extent possible.

- New development should be prevented in flood hazard areas or built to minimize risk.
- Existing development in hazardous areas should be protected retrofitted, or relocated to make it less susceptible to damage.
- Flood control projects and maintenance practices must be designed to protect and enhance riparian habitat.
- All flood management solutions must be consistent with applicable land use plans and regulations.

Developing flood hazard management plans is a high priority for SWM. Through such plans, the principles described here can be applied to existing and known future hazards and the best alternatives can be implemented before a damaging flood occurs. As an example, through the Snohomish River Comprehensive Flood Control Management Plan process, SWM facilitated an agreement between all the special districts in the valley, regarding equitable dike heights and construction standards. This plan has guided levee reconstruction and rehabilitation efforts since then.

► Selection of Preferred Flood Damage Reduction Strategies

SWM follows the same process whether an issue is addressed through a plan or is a "hot issue" that requires an immediate evaluation. A series of alternatives that address the problem are formulated, and then evaluated, using the following criteria, and the best alternative is selected.

Technical Feasibility

The engineering and technical merits of a project or alternative should be assessed and those that are not feasible should be dropped from further consideration.

Benefit vs. Cost

Benefits should be measured as a project's effect on flood damages over the entire river system. Costs should be measured as public and private costs for implementing and maintaining the project over the long term. Benefits may also include non-quantifiable societal benefits, such as protecting agricultural land, recreational opportunities, cultural areas, or historical areas. For a project to receive approval, the benefits of reducing flood damage over the entire river system should exceed the long-term costs.

Risk to Life or Bodily Harm

The effect of a project on public safety and health should be evaluated both upstream and downstream of the site. If life and limb are currently endangered, the project should have a beneficial impact on public health and safety to receive positive consideration. If there is currently no risk to life or bodily harm, the project should not increase that risk.



Environmental Impacts

The environmental impacts of a project, including its effect on fish and wildlife habitat, wetland, water quality, and other resources, should be evaluated both upstream and downstream of the project site. The net environmental impacts of a project (including mitigation measures) over the long term should be beneficial or insignificant.

County Responsibilities

The level of County involvement in implementing a selected alternative will vary. Recommended alternatives developed through the planning process may often be assigned to other entities for implementation. The County should be fully involved in situations where there is an impending threat to public safety or County property. The County may cooperate or support some situations, such as a private residence in imminent risk of destruction or another jurisdiction's property at risk. The County may not participate at all in situations where another jurisdiction has full authority and where natural river processes are threatening undeveloped property. The County may also oppose proposed flood hazard reduction strategies that others have proposed that do not meet the evaluation criteria.

► Areas of Existing Program Emphasis

In accordance with the above flood hazard management goals and principles, SWM has established a flood hazard management program with the following four major program areas.

Strategic Planning – Flood Hazard Management Plans

Flood Plans. Developing strategic plans for flood-prone rivers is a high priority for the County. These plans are based on thorough scientific and engineering assessments of flood hazards. They provide sound guidance for project selection, project design, land use regulations, and other action priorities. The planning process involves building a technical understanding of a river (typically through computer modeling) to fully understand the patterns of flooding and flood damage that occur and to provide a method of evaluating how proposed solutions might reduce flood damages. Input, from citizens and affected agencies, is solicited. Cost-effective solutions are then selected, ranging from new flood control structures to land use policies and better early warning systems.

Flood Warning. SWM operates a real-time flood warning system, consisting of river and rain gages, transmitting data through radio and telephone to automated data collection programs running at the SWM office and the Department of Emergency Management. This data, along with additional data from other sources, is used to predict and monitor flood levels.

The data is shared with external agencies and cities, such as the Town of Index, City of Arlington, and the French Slough Flood Control District. During flood emergencies, SWM provides technical support at DEM on flood hydrology.

Flood Information. SWM distributes educational outreach materials, such as the SWM flood brochure and FEMA publications, to increase citizen and agency awareness of flood hazards, regulations and emergency services.

River Monitoring. SWM collects hydrologic data, conducts regular channel surveys and post-flood high-water surveys. In addition, SWM performs other forms of river monitoring to track changes and to ensure that the data required for good technical analysis of flood hazard reduction strategies is available.

Mitigation. The Federal Emergency Management Agency (FEMA) periodically offers grant funding for cost-effective local projects that reduce flood damage. SWM staff will assist interested owners of repetitively flooded homes in applying for these grants, which are awarded following a competitive process. As grants are awarded, SWM staff will manage the process and oversee the disbursement of funds when project milestones are completed.



Capital Improvement Projects

Snohomish County designs and constructs levees, bank stabilization projects and other structural flood controls. Most of these new construction projects are identified by the flood hazard management plans described above.

SWM regularly inspects and maintains existing flood control projects and assists other County departments, districts and private citizens on the ongoing inspection and maintenance of roads and flood control structures.

Upon request, SWM also provides technical advice on bank stabilization techniques to citizens. This advice helps landowners identify cost-effective and environmentally friendly ways to reduce stream bank erosion.



During floods, SWM patrols levees and other flood control projects, assists in handling calls and directing resources, distributes sand and sandbags to conduct emergency repairs, and works with the Corps of Engineers, Department of Emergency Management and other agencies to ensure an effective emergency response.

Outreach

Flooding is one of several topics that are incorporated into SWM's outreach programs. These programs include:

- Watershed education for adults and children, including Watershed Keepers and school-based programs.
- Events, meetings, newsletters and workshops to involve citizens in SWM's plans and programs.
- Stewards work to help landowners address drainage and flooding issues.
- During floods, SWM, in coordination with DEM and Road Maintenance, contributes up to 50 additional staff to handle phone banks set up to respond to citizen requests for assistance. This frees up SWM staff to provide field assistance visits and flood monitoring and data collection.

► Challenges and Opportunities

Flood hazard management has been a local service since early in the County's history. New laws and limited funding have spurred a transition from structural fixes, such as building dikes and levees, to new approaches, such as purchasing and removing frequently flooded houses and providing a warning of impending floods. These new approaches provide an opportunity to reduce damages and protect people while protecting habitat and reducing long-term cost of dike maintenance and repair. Many challenges remain:

- **Flooding is a natural process.** Because flooding is a natural process that cannot be entirely controlled, it is not amenable to a one-time fix. Sustained efforts are needed to minimize the risk to human life, property, and the environment that results from flooding.
- **Funding for flood control structures.** The County has a system of flood control structures built in the past. Federal funding for flood control structures has become increasingly scarce and difficult to obtain, shifting the burden onto local governments and special districts for continued maintenance and repair.
- **Existing System Maintenance.** Snohomish County has legal agreements with the Corps of Engineers to maintain a number of the flood control structures. The reality is that there are insufficient staff members and financial resources to meet those obligations. There are levees around the County that are inaccessible to vehicles and have not been maintained in decades.

- **Evaluating the role of dikes and levees.** The County and other entities own an extensive network of dikes and levees. Many are very old. Some protect important infrastructure, but there are others whose purpose is no longer clear. In some cases, more money has been spent repairing a structure over time than the land and development it is protecting are worth.
- **Impact of ESA listings.** Flood control structures are becoming increasingly difficult to construct and repair since Puget Sound Chinook salmon, bull trout, and Killer whales (Orcas) were listed as endangered species, and Puget Sound Steelhead was listed as a species of concern, under the Endangered Species Act (ESA). Both permitting and mitigation requirements are more stringent, and federal funding for repairs to flood control structures is difficult to obtain.
- **Cooperative Bank Stabilization Program.** This program reimburses private landowners for material costs when they construct bank stabilization projects in accordance with County standards. In the past this was an effective outreach and education program and provided a way to make bank stabilization projects more environmentally friendly than the minimum development codes required. The regulatory codes are now much stricter and the cost of obtaining permits can now exceed construction costs on some of these projects.
- **Limited resources.** The number of Snohomish County residents affected by flooding has increased while funding for flood hazard management has remained unchanged for many years. Thus the ability to fund flood hazard reduction measures is very limited. The majority of the floodplains where work is done lie outside SWM fees areas. The exceptions are the lower end of the Stillaguamish River and the Pilchuck River. Most funding for flood hazard work comes from the River Improvement Fund, which has remained at a small and static level for many years. Many of the bigger projects must wait for post-disaster grant funds to implement. Delaying fixes until funds are available can increase long-term costs, since previously flooded structures risk new flood damages each winter.
- **Floodplain development/land use.** Agricultural zoning of the big river floodplains has helped keep development densities, and hence flood damages, relatively low. Seventy-five percent of farms are less than 50 acres in size, and zoning allows up to one house per 10 acres. This, combined with flood hazard regulations that do not fully address the true risks of floodplain development, could lead to hundreds more houses built in hazardous locations.
- **Flood hazard regulations.** Snohomish County's current flood hazard development regulations are consistent with or exceed National Flood Insurance Program (NFIP) standards. The codes were created primarily to address inunda-



tion damages, and use 20 year old mapping and analysis. The fundamental basis of the codes is that development within the FEMA (Federal Emergency Management Agency) mapped Special Flood Hazard Areas is allowed to increase the 100-year flood levels up to one foot. Floods in the 1990s showed the inadequacies of the current code and its failure to fully address the true flood hazards. As a result, development is being allowed in areas that are at risk of destruction in the next large flood. Riparian buffer setbacks based on environmental criteria have helped reduce the risk somewhat.

- **Lack of public awareness.** Public awareness of flood risk is low, especially when it has been many years since a flood. In particular, there are always new residents moving into the floodplain who are not aware of the risks or the resources available to help them minimize those risks.

At the same time, opportunities exist:

- **Integrated strategies.** There are numerous opportunities to link flood hazard reduction strategies with habitat restoration strategies on the county's rivers. This offers the opportunity to leverage additional funding sources, reduce flood hazards and increase salmon habitat.
- **Low-density use.** The big river floodplains are still primarily low density agricultural use, allowing more flexibility in hazard reduction strategies and lower implementation costs.
- **Targeted outreach.** The relatively low population on the floodplains means that outreach efforts can be effectively targeted to those directly impacted by floods.